

# Particle Manipulation System

## ABSTRACT OF THE DISCLOSURE

Methods and apparatus are disclosed for using a beam of energy, specifically laser light (46), to transport, suspend or trap non-atomic size particles (59) within a hollow-core optical fiber (50), manipulating the particles (59) along the fiber (50) over distances and depositing them on a substrate (58). A laser generates a beam (46) focused on a fiber (50) entrance (56). A source (54) delivers particles (52) to the entrance (56). Particles (52) are drawn into the beam (46) and propelled through the core (48) of the fiber (50). Forces ( $F_1$ - $F_4$ ) on a particle (12) generated by reflection, absorption and refraction of laser light (20) keep the particle (12) close to the fiber's center and propel it along the fiber's length. A variety of micron-size particles, including solids, solid dielectrics, semiconductors, liquids, aerosols and living cells are conveyed. The invention is adapted to direct-writing of micron-sized features (66-74) on surfaces, for example, microcircuits and microcircuit components for "smart" credit cards and biological implants, to recording emission spectra of trapped particles and to many other such uses. Deposited material (172) is treated by laser light (174) by particle melting, decomposition, sintering or other chemical and mechanical reactions caused by laser interaction with the particle. Resulting, treated depositions have desirable mechanical and electrical properties for electronics and micro-electronic-mechanical system applications.